FACTORS INFLUENCING ATTRITION IN THE MARINE CORPS

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The George Washington University
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0. Introduction

The focus of research on maintaining military manpower levels in an all volunteer environment has been on problems relating to the acquisition of new enlistees [1] [2] or the retention of first-term enlistees [3] [5] [6]. Almost no attention has been given to the problem of first-term attrition, i.e., the loss of manpower that occurs between enlistment and completion of the initial service contract. One reason for this is the difficulty of defining attrition. Despite this difficulty, it is clear that first-term attrition imposes an important drain on the manpower available to the military services. Furthermore, recent trends in the composition of the Marine Corps suggest that the attrition rate may increase in the future. For this reason, it is useful to study the variables influencing attrition, since an understanding of these factors can provide insights for improving manpower management.

The optimium composition of a work force depends, obviously, on a large number of factors. These include the size of the market for recruits, which in turn depends on the elasticity of supply of recruits and prevailing wage rates; turnover of workers, i.e., the

extent to which new recruits stay on the job; and the trainability of recruits given that they remain in the work force. Complicating the problem of determining optimium work force composition is the possibility that the variables influencing turnover are not the same as those influencing trainability, and both sets of variables may be inconsistent with the objective of maximizing the number of recruits available for hire.

This paper is directed at quantifying the impact of variables affecting the second aspect of work force composistion, i.e., turnover associated with attrition of first-term enlistees.[1/] To some extent this can be accomplished by simply examining historical data on attrition. Such data, however, do not yield numerical estimates of the probability of attrition among individuals with a given set of characteristics. To obtain quantitative estimates of these probabilities, multidimensional contingency table analysis is employed. This procedure yields the probability of completing one's service contract for a profile of predictor variables. For example, for Marines A and B who entered service in 1968 and have the profiles shown below, the probability of satisfactorily completing their service contract ranged from .34 to .91. Further analysis indicates that the most important variables influencing attrition are education and length of enlistment.

Probability of Completing Service Contract
for Individuals with Specified Characteristics

	A	B
Age at Enlistment	17 years	18-19 years
Education	Less than high school	High school or above
Length of Enlistment	4 years	2 years
Mental Group	IV or V	I or II
Race	White	White
Probability of Completing Service Contract	.34	.91

[1/] Marine Corps data are utilized. The findings and conclusions, however, should be of interest to the other services and have implications for other labor markets.

Discussion of the contingency table model is found in Section 2. The empirical findings of the study are presented in Section 3. Some policy alternatives stemming from the findings are discussed in the last section.

1. The Data Base and Variables Included in the Analysis

The data base is a longitudinal personnel history file developed by the Marine Corps. Hereafter it is referred to as the cohort file. The file contains significant historical information for all first-term enlistees into the Marine Corps Regular Establishment from initiation into active duty until separation from service or first reenlistment. The complete file contains information for over 700 thousand first-term enlistees who entered the Marine Corps between calendar years 1962 and 1972. The cohort of enlistees entering the Marine Corps in 1968 was chosen for intensive study, as this was the latest cohort for four-year enlistees. The 1970 cohort of enlistees was also examined to see whether the findings for a more recent year were consistent with those for the earlier period.

Several kinds of data are contained in the cohort file. These pertain to the date of entry (active duty accession date); information describing the first-term enlistee (age, race, education, length of enlistment, home of record at the time of enlistment, etc.); significant events related to the enlistee's attachment to the Marine Corps (whether or not basic training was completed, whether or not the initial service contract was completed, whether or not reenlistment occurred); and other information describing his activities while in the military (primary and current job, etc.).

As can be readily seen, a large number of factors that might affect attrition are contained in the cohort file. A complete list of the variables used in the analysis is given in Table 1. The discrete categories employed to measure these variables are shown at the right. Most of the variables such as age at enlistment, region and

TABLE 1

Predictor Variables Used in the Analysis

	Number of Categories	Categories
Age at Enlistment (A)	3	17; 18 or 19; 20 or more
County Population (P)[a/]	3	50,000 or less; 50,001 - 1,000,000; greater than 1,000,000
Education (U)	2	Less than high school; high school and above
Length of Enlistment (L)	3	Two; three; four or six years
Mental Group (G)[b/]	3	I or II; III; IV or V
Military Occupation (O)	4	Ground combat; general repair; clerical and semi-skilled; other skills
Region (N)[c/]	4	East; North; South; West

a/ Population in 1960 of county of residence at time of enlistment.

b/ As measured by the General Classification Test.

c/ Region of residence at time of enlistment as defined by the Bureau of the Census.

population size of county of residence prior to enlistment, length of enlistment, and level of education are self-explanatory. Two of the variables, however, require further description.

Four military occupational groups are distinguished in the analysis to determine the impact of occupation on attrition. Ground combat includes the infantry, artillery, and tank specialties; general repair refers to such occupations as electricians and plumbers, aircraft maintenance, and telecommunications repair; the clerical and semi-skilled occupations include personnel administration, supply, food service, and motor transport excluding repairmen or mechanics; such diverse occupations as photography, printing, mapmaking, and music comprise the "other skill" group. It should be noted that the occupational field refers to an individual's primary occupational specialty. Although an individual's primary occupational specialty is assigned after boot camp, the information is not entered into the cohort file until his enlistment terminates. Therefore, the information does not indicate whether or not occupational training (as distinct from boot camp training) was successfully completed. Since relatively few attritions occur during training, it may be presumed that the information refers to attained skill after training has been completed. Hence, when occupational field is used as a predictor variable, it represents the type of training received and not the difficulty of becoming qualified in a skill area.

Mental group is a proxy for general intelligence and is measured by the grade received on the General Classification Test(GT). This test, which consists of arithmetic and verbal questions, is given to an enlistee after he has been accepted into the Marine Corps. Since a study of factors influencing trainability is contemplated at a later date, the GT, which

is used to place enlistees in military occupations, is employed in the analysis rather than the Armed Forces Qualification Test (AFQT).[2/]

2. The Contingency Table Model

In this section, we illustrate the application of contingency table analysis to the problem of attrition. Rather than define what we mean by attrition, we follow Marine Corps usage and define the complement of attrition, i.e., successful completion of one's service contract or reaching end of service (EAS). An individual is said to reach EAS when he serves, say 24 months (excluding desertion and other "bad" time) of a two-year enlistment contract, or when he receives an early discharge at the convenience of the government (as occurred at the end of the Vietnam War), or the individual reenlists prior to the expiration of his initial enlistment contract. Additionally, reaching EAS is defined to mean that the individual has met a minimum standard of quality as indicated by his having received an honorable or general discharge.[3/] Thus, in this definition, service equal to the length of the service contract is a necessary, but not sufficient, basis for reaching EAS. A minimum standard of quality must also be attained; hence, the definition of attrition used in this paper differs from what is often meant by this term. It should be noted also that we deviated from

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[2/] The AFQT, which is given to enlistees prior to enlistment, is another means of classifying enlistees by mental group. In addition to arithmetic and verbal questions, the AFQT tests tool knowledge and pattern recognition. As a result, the AFQT and GT measure different facets of intelligence which are not necessarily correlated with each other.

[3/] A general discharge indicates less than desired performance, but not sufficiently poor to warrant an undesirable, bad conduct, disciplinary or dishonorable discharge.

the Marine Corps procedure of classifying individuals killed in combat as not having reached EAS. Such individuals are excluded from the study, i.e., they are treated neither as reaching EAS or not reaching EAS.

Because the analysis is based on a large number of categorical variables, regression analysis and similar multivariate techniques for continuous variables become inefficient and inappropriate for this situation. Multidimensional contingency table analysis, which we now explore, is more suitable.[4/]

We are interested in accounting for the variation in reaching EAS in a parsimonious way and with meaningful variables. Consider a simple example with two factors, reaching or not reaching EAS and age. Assume age is categorized into two levels, i.e., younger or older. A table showing the retainment outcome, i.e., the event of reaching or not reaching EAS, and age of forty individuals might look as follows:

	Younger	Older
Reaching EAS	5	15
Not Reaching EAS	15	5

From this table the probability estimates

	Younger	Older
Reaching EAS	.125	.375
Not Reaching EAS	.375	.125

or more generally

	Younger	Older
Reaching EAS	$p_{11} = .125$	$p_{12} = .375$
Not Reaching EAS	$p_{21} = .375$	$p_{22} = .125$

are obtained.

[4/] The discussion of contingency table analysis which follows is adopted from [4].

The overall probability that a person reached EAS is $p_{11} + p_{12} = .5$. The probability that an individual who reaches EAS is in the younger age group is

$$\frac{p_{11}}{p_{11} + p_{12}} = \frac{.125}{.125 + .375} = .25 .$$

Similarly, the probability that an individual who reaches EAS is in the older age group is

$$\frac{p_{12}}{p_{11} + p_{12}} = \frac{.375}{.125 + .375} = .75 .$$

A related measure denoted as an "odds" measure has an interpretation well known to bettors. In the above example, if one wagers that a person selected at random will reach EAS, the overall odds, i.e., the odds of reaching EAS, regardless of age, are one to one or even. Knowledge that the bet is on the younger or older age group changes the odds. The odds are one to three for the younger age group; three to one for the older age group.

The information contained in this and the preceding table is described in terms of three characteristics: the overall probability that a person will reach EAS, the probability that a younger person will reach EAS, and the probability than an older person will reach EAS. The basic problem in a more complex table is to identify the minimum number of probabilities that must be specified to adequately describe the table. The specification of probabilities given in the above example is one approach to the problem. However, recent research has developed a more formal descriptive model similar to analysis of variance or regression models. Instead of dealing directly with cell probabilities, it is convenient to deal with their logarithms. These new variables, the logarithms of the cell probabilities, have characteristics similar to measurement data; they can be incorporated into a

linear model whose parameters indicate the contribution of the various factors and their interactions to the cell probability.

The linear model for estimating the (natural) logarithms of the cell probabilities (for our analysis where we fix and employ only the marginals) is

$$\ell np_{ta} = \mu + \alpha_t^T + \alpha_a^A + \alpha_{ta}^{TA}, \quad t = 1, 2 \quad a = 1, 2, \qquad (1)$$

where t denotes the retention outcome and a the age groups. The constant μ is a general mean indicating the average value of ℓnp_{ta}. The parameters α^T indicates the "effect" of the retainment outcome on ℓnp_{ta} independent of age; α^A measures the effect of age on ℓnp_{ta} independent of the retainment outcome; α^{TA} measures the interaction effect of retainment outcome and age on ℓnp_{ta}. For the simple case where all the p_{ta} (and consequently all the ℓnp_{ta}) are equal, α^T and α^A are zero since ℓnp_{ta} does not vary with either the retainment outcome or age; and for this reason, too, α^{TA} is zero. In this simple case, p_{ta} is equal to the anti-log of μ which is the overall probability that a person reaches EAS.

The model in (1) allows the step-by-step computation of cell probabilities similar to regression analysis. For example, if the retainment outcome is considered as a function of age, the odds of retainment or reaching EAS ($t = 1$) to non-retainment or not reaching EAS ($t = 2$) are

$$\frac{p_{1a}}{p_{2a}}, \quad a = 1 \text{ for the younger age group,}$$
$$a = 2 \text{ for the older age group.}$$

Using the model in (1) to obtain these odds in logarithmic form (denoted hereafter as the log odds), we get

$$\ln\frac{p_{1a}}{p_{2a}} = (\mu + \alpha_1^T + \alpha_a^A + \alpha_{1a}^{TA}) - (\mu + \alpha_2^T + \alpha_a^A + \alpha_{2a}^{TA}) = \quad (2)$$

$$2\alpha_1^T + 2\alpha_{1a}^{TA}$$

where $\alpha_1^T = -\alpha_2^T$ and $\alpha_{1a}^{TA} = -\alpha_{2a}^{TA}$.

Since the α parameters measure deviations from a general mean, a deviation from the mean at one level leads to a deviation in the opposite direction at the other level. Replacing $2\alpha_1^{TA}$ by β^T and $2\alpha_{1a}^{TA}$ by β_a^{TA} to simplify the notation in (2) yields

$$\ln\frac{p_{1a}}{p_{2a}} = \beta^T + \beta_a^{TA}, \quad \begin{array}{l} a = 1 \text{ for the younger age group,} \\ a = 2 \text{ for the older age group.} \end{array} \quad (3)$$

From (3) the log odds of reaching EAS to not reaching EAS are seen to depend on β^T , the general mean for the log odds, and β_a^{TA} , the relationship between age and the retention outcome.

To further illustrate these ideas, let us consider another example. Assume that reaching EAS is dependent on two variables: length of enlistment, L , and level of education, U . Then $p_{t\ell u}$ represents the probability that a specified retention outcome occurs, given an individual's length of enlistment and educational level. Following the previous example, the logarithm of the odds of reaching EAS to not reaching EAS as a function of the predictor variables can be written as

$$\ln\frac{p_{1\ell u}}{p_{2\ell u}} = \beta^T + \beta_\ell^{TL} + \beta_u^{TU} + \beta_{\ell u}^{TLU} . \quad (4)$$

Each of the β parameters has the same interpretation given previously. β^T is a general mean for the log odds. The β_ℓ^{TL}, $\ell = 1$ (two-year enlistment), $\ell = 2$ (three-year enlistment), $\ell = 3$ (enlistments of four or more years)[5/] are numerical measures of the impact of enlistment length on retention. Similarly, the β_u^{TU} are numerical measures of the impact of educational level on retention, where the subscript u identifies the level of education, $u = 1$ less than high school and $u = 2$ high school or above. The parameters $\beta_{\ell u}^{TLU}$ are interaction terms. It may be, for example, that the impact of length of enlistment on retention depends on educational attainment. One might expect this if non-high school graduates have a greater difficulty than high school graduates in meeting obligations which span long periods of time. The presence of a joint interaction effect of length of enlistment and educational attainment on retainment implies non-zero $\beta_{\ell u}^{TLU}$.

By exponentiation of each side of the log-linear model (4), the odds of reaching EAS to not reaching EAS (hereafter referred to simply as the odds of reaching EAS) can be written in the form

$$\frac{P_{1\ell U}}{P_{2\ell u}} = \delta^T \delta_\ell^{TL} \delta_u^{TU} \delta_{\ell u}^{TLU} \qquad (5)$$

where the δ's are the anti-logs of the β's. In this form of the model, δ^T can be interpreted as the overall mean odds of reaching EAS, which is modified by more detailed information about the levels or values of the predictor variables and their interactions.

[5/] A small number of enlistments in this category are six-year enlistments; for convenience this group is referred to as the four-year enlistment group.

For the full model, the odds of reaching EAS become

$$\frac{P_{1\ell ug....}}{P_{2\ell ug....}} = \delta^{T}\,\delta_{\ell}^{TL}\,\delta_{u}^{TU}\,\delta_{g}^{TG},\ldots,\delta_{\ell u}^{TLU},\ldots,\delta_{\ell ug}^{TLUG},\ldots, \quad (6)$$

where $\delta_{\ell u}^{TLU},\ldots,$ take into account first order interaction effects, $\delta_{\ell ug}^{TLUG},\ldots,$ second order interaction effects, etc.[6/] For the full model, the overall odds δ^{T} is estimated as $\hat{\delta}^{T} = e^{\hat{\beta}^{T}} = e^{.85} = 2.34$, that is, the odds are 2.34 to one in favor of reaching EAS.[7/] If the odds of reaching EAS are desired for four-year, non-high school enlistees, we need to compute

$$\hat{\delta}^{T}\,\hat{\delta}_{3}^{TL}\,\hat{\delta}_{1}^{TU}\,\hat{\delta}_{31}^{TLU} = (2.34)\ (0.53)\ (0.58)\ (0.86) = .62$$

where the last term measures the interaction effect of L and U. Note, the odds of reaching EAS for four-year enlistees with less than a high school degree would have been overestimated if the first order interaction effect had been omitted from the calculation.

As can be seen from these examples, the estimation of a small number of δ's permits the computation of odds of reaching EAS for individuals having very diverse characteristics. As in the case

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[6/] The superscripts are the same as those used in Table 1 to denote the variables examined in the study.

[7/] Note that this is not the odds that would be computed directly from the observations; these odds are computed by taking the logarithmic transforms of the observations, and then transforming the averages back to the odds domain. Thus, this "mean odds" is a multiplicative mean, not an additive mean.

of regression analysis, the coefficients of the linear model (4) (and consequently the δ's in (6)) show the effect of a change in a variable holding all the other variables constant. Thus, $\hat{\delta}_{\ell}^{TL}$ and $\hat{\delta}_{\ell u}^{TLU}$ measure the direct and indirect effects of length of enlistment on the odds of reaching EAS net of the effects of other variables such as age, race, etc.

Given the odds of reaching EAS for individuals with a given set of characteristics, it is a simple matter to compute the probability of reaching EAS for the group from the relationship.

$$\text{Probability of reaching EAS} = \frac{\text{odds of reaching EAS}}{1 + \text{odds of reaching EAS}}. \quad (7)$$

For the illustrations given above, one finds that the probability of reaching EAS corresponding to the odds of reaching EAS is as follows:

Odds of Reaching EAS	Probability of Reaching EAS
2.34	0.70
1.23	0.55
0.62	0.38

In these calculations it is important to distinguish between individual δ's referred to as "odds factors" (e.g., δ_{ℓ}^{TL}, δ_{u}^{TU}, $\delta_{\ell u}^{TLU}$) which indicate how the overall mean retention odds, δ^{T}, is modified and the product of δ's which measures the odds of reaching EAS for individuals with a specified set of characteristics. Since (7) converts the odds of reaching EAS for a given group of individuals to the probability of reaching EAS for that group, it cannot be applied to the individual δ's.

The above discussion makes clear that a large number of parameters may enter the contingency table model, thus raising the problem of identifying which parameters are to be included in the model and which are to excluded. Statistical distribution theory and a measure I^*, which is similar to R^2, the multiple correlation coefficient in regress[redacted]sis, is used to resolve this problem.

In regression analysis the explanatory value of a set of predictor variables is measured by the percentage of variation in the dependent variable explained by the predictor variables. The base measure of variation in regression analysis is the sum of squares about the mean of the dependent variable, i.e., $\Sigma(Y_i - \bar{Y})^2$. As predictor variables are added to the model, the predicted values of the dependent variable, $\hat{Y}_i$, are used to measure the amount of variation, $\Sigma(Y_i - \bar{Y})^2$, explained. The percentage of base variation explained is then

$$100\ R^2 = 100\frac{\Sigma(Y_i - \bar{Y})^2 - \Sigma(Y_i - \hat{Y})^2}{\Sigma(Y_i - \bar{Y})^2}.$$

For contingency tables, the base measure of variation is computed either as the chi-square statistic[8/]

$$\Sigma\frac{(O - E)^2}{E}$$

or the information measure

$$2\ \Sigma\ O\ \ell n\ \frac{O}{E}$$

[8/] The symbol O stands for the observed cell count and E the estimated cell count. The summation is over all cells in a table.

under the hypothesis that all β parameters in (4) except the general mean are zero. I^* is then the percentage of base variation explained by the introduction of some collection of β parameters into the model, i.e.,

$$I^* = \frac{\left(\Sigma\ O\ \ln \frac{O}{E}\right)_{\text{Base}} - \left(\Sigma\ O\ \ln \frac{O}{E}\right)_{\text{Model}}}{\left(\Sigma\ O\ \ln \frac{O}{E}\right)_{\text{Base}}} .$$

The prime objective is to find the most important parameters. When the number of observations is large as is the case in this study, parameters signifying marginal impact will be statistically significant. In the models discussed in the next section, the convention is adopted of excluding parameters when they increase I^* by less than two percentage points.

3. Factors and Policies Relating to Reaching EAS

Before discussing the substantive findings of the study and the policy implications that may be drawn from these findings, it will be useful to first indicate some summary quantitative measures of the impact of the variables examined on retention. The applications of the model, the number of observations entering into each application, and the percentage of variation in retention explained by each Model, I^*, is presented below. As can be seen, uniformly high values of I^* were obtained in all applications of the contingency table technique. This was achieved by examining the main or direct effects and the more important first order effects; parameters measuring less important first order effects and all higher order effects were not included in the models.

The 1968 cohort of enlistees received the most attention since this was the latest cohort for which complete retention information available for all four-year enlistees. The first application of the contingency table technique was to assess the impact of the variables

Application No. a/	Population	Criterion of Retention	Population Size	Percentage Variation Explained by Model, I*
1	All entrants into the Marine Corps in 1968	Reached EAS from entrance	71,977	97.9
2	All entrants into the Marine Corps in 1968	Completed boot camp	75,787	89.6
3	All entrants into the Marine Corps in 1968	Completed one year of service	74,917	88.7
4	All entrants into the Marine Corps in 1968	Completed two years of service	74,917	93.8
5	All entrants into the Marine Corps in 1968	Reached EAS from boot camp	69,617	94.5
6	All entrants into the Marine Corps in 1968	Reached EAS from boot camp	69,893	95.1
7	Four year entrants into the Marine Corps in 1968	Reached EAS from boot camp	23,729	95.2

a/ See Table 6 for the variables included in each model application.

in Table 1 on retention of the 1968 cohort where retention is defined in terms of reaching EAS. The probabilities of reaching EAS for this group are shown in Table 2. To illustrate the interpretation to be given to these figures, when other factors such as age and race are held constant, the probability of reaching EAS from entrance into the Marine Corps is .38 for four-year, non-high school enlistees but is .74 for four-year, high school graduates. Here we have a very clear example of the way in which the contingency table model identifies interactions among predictor variables.

The range in retention probabilities can be used to measure the impact of a variable on retention. In the discussion that follows variables are grouped into three categories: important, low importance, and not important depending on whether the range in the retention probability between levels of the predictor variable is in the neighborhood of 15, 5, or 0 percentage points, respectively. It is recognized that this characterization is a gross one as the range in retention probabilities depends on the manner in which a variable is measured. For example, the range in retention probabilities for the mental group variable would be greater if five classes had been used intead of three. Nonetheless, the measurement groupings utilized seem reasonable in light of conventional usage in delineating individuals by characteristic. On the basis of the convention just noted, education and length of enlistment are important variables influencing retention; mental group, age, and race are of low importance.[9/] As can be seen from Table 2, the range in retention probabilities varied from .36 (= .74 - .38) to .16 (= .87 - .71) for the length of enlistment variable, depending on level of education. Likewise, the differential ranged from .33 to .13 for the education variable, depending on length of enlistment. For the "region" and "county population" variables, on the other hand, the range in retention probabilities was close to zero.

[9/] Mental group is found to be of low importance in influencing retention when the AFQT test is used as well as when the GT test is used.

TABLE 7

Probability of Reaching EAS from Entrance into the Marine Corps: [a]
Two-, Three-, and Four-Year Enlistees, 1968 Cohort

		Probability of Reaching EAS	
Age:	17 years	.66	
	18-19 years	.72	
	20 years and over	.71	
Race:	White	.74	
	Non-white	.66	
		Level of Education:	
Length of Enlistment:		Less than H.S.	H. S. or Above
	2 years	.74	.87
	3 years	.59	.80
	4 years	.38	.71
Mental Group: [b]			
	I and II	.60	.82
	III	.59	.80
	IV and V	.53	.77
Region: [c]			
County Population: [c]			

a/ The overall probability of reaching EAS is .70.

b/ Based on the General Classification Test.

c/ Approximately the same as the overall probability of completing boot camp.

The very small probability of reaching EAS, .38, for four-year enlistees who failed to finish high school raises an important question. Is the probability low because the four-year enlistee is of poorer quality, everything else being the same? Or is the probability low, not because he is of poorer quality, but because he has more time to get into trouble. In the former case, it might be preferable to reduce the intake of non-high school graduates. In the latter case, he might be enlisted, say, for two years only or even less, i.e., less than the time in which he might get into trouble. In order to determine the effect of time on attrition, the model described in Table 1 was repeated allowing time to vary. This was achieved by varying the criteria of retention. The alternative criteria of retention utilized in measuring the impact of time on retainability were a) completion of boot camp, b) completion of one year of service, and c) completion of two years of service. The probability of reaching each of these milestones as a function of each of the predictor variables is shown in Tables 3, 4, and 5, respectively. A summary of these three applications of the model is found in Table 6.

One of the major conclusions to be drawn from an examination of Tables 3, 4, and 5 is that the impact of the predictor variables varies over time. For example, knowing the age of an individual contributes to predicting whether he will reach EAS. The retention probability varies inversely with age up to two years of service; between two and four years of service, however, it varies positively with age. Apparently, youth is an asset during boot camp, but becomes less so as the physical aspects of military service become less demanding. As with age, race is of low importance in its impact on reaching EAS; it is of little importance up to two years of service, but becomes more important after this period.

A second major point to note is that the overall retention probability remains high up to the first year of service but then declines rapidly thereafter. However, while the probability of retention declines dramatically as enlistment length increases for

TABLE 3

Probability of Completing Boot Camp from Entrance into the Marine Corps: a/ Two-, Three-, and Four-Year Enlistees, 1968 Cohort

		Probability of Completing Boot Camp	
Age:	17 years	.97	
	18-19 years	.96	
	20 years or over	.94	
Race:	White	.95	
	Non-white	.97	
		Level of Education:	
Length of Enlistment:		Less than H.S.	H.S. or Above
	2 years	.94	.98
	3 years	.94	.98
	4 years	.93	.97
Mental Group: b/			
	I and II	.95	.98
	III	.95	.98
	IV and V	.90	.95
Region: c/			
County Population: c/			

a/ The overall probability of completing boot camp is .96.

b/ Based on the General Classification Test.

c/ Approximately the same as the overall probability of completing boot camp.

TABLE 4

Probability of Completing One Year of Service in the Marine Corps: [a] Two-, Three-, and Four-Year Enlistees, 1968 Cohort

		Probability of Completing One Year of Service	
Age:	17 years	.94	
	18-19 years	.93	
	20 years or over	.90	
Race:	White	.92	
	Non-white	.94	
		Level of Education:	
Length of Enlistment:		Less than H.S.	H.S. or Above
	2 years	.90	.95
	3 years	.90	.95
	4 years	.88	.94
Mental Group: [b]			
	I and II	.91	.96
	III	.91	.96
	IV and V	.85	.91
Region: [c]			
County Population: [c]			

a/ The overall probability of completing one year of service in the Marine Corps is .93.

b/ Based on the General Classification Test.

c/ Not included.

TABLE 5

Probability of Completing Two Years of Service in the Marine Corps: [a] Two-, Three-, and Four-Year Enlistees, 1968 Cohort

		Probability of Completing Two Years of Service	
Age:	17 years	.81	
	18-19 years	.82	
	20 years or over	.79	
Race:	White	.81	
	Non-white	.80	
		Level of Education:	
Length of Enlistment:		Less than H.S.	H.S. or Above
	2 years	.77	.88
	3 years	.72	.86
	4 years	.68	.87
Mental Group: [b]			
	I and II	.74	.89
	III	.74	.87
	IV and V	.69	.84
Region: [c]			
County Population: [c]			

a/ The overall probability of completing one year of service in the Marine Corps is .81

b/ Based on the General Classification Test.

c/ Not included.

TABLE 6

Summary of Findings

Application No.	Population	Criterion of Retention	Importance of Predictor Variable [a]						Probability of Retention		
			Age [b]	Education	Length of Enlistment	Mental Group	Military Occupation	Race	Overall	A	B
1	All entrants, 1968	Reached EAS (from entrance)	L [b]	I	I	L	-	L	.70	.34	.91
2	All entrants, 1968	Completed boot camp	L [c]	L	U	L	-	U	.96	.90	.98
3	All entrants, 1968	Completed one year	L [c]	L	U	L	-	U	.93	.86	.97
4	All entrants, 1968	Completed two years	U	I	U-L [d]	L	-	U	.81	.66	.91
5	All entrants, 1968	Reached EAS (from boot camp)	L [b]	I	I	U	L	L	.75	-	-
6	All entrants, 1968	Reached EAS (from boot camp)	I [b]	-	I	L-I [e]	L	L	.75	-	-
7	Four-Year Enlistees, 1968	Reached EAS (from boot camp)	I [b]	I	-	U	L	I	.60	-	-

a/ I denotes that the variable is important; L denotes the variable is of low importance; and U means that variable is unimportant.

b/ Retention probability increases with age.

c/ Retention probability decreases with age.

d/ Depending on level of education.

e/ Depending on length of enlistment and military occupation.

an individual who lacks a high school degree, the decline is small for individuals who have finished high school. Thus, lack of a high school degree exerts a substantial negative influence on retention only after a sufficiently "long" period of time has elaspsed; for Marines, this period appears to be between one and two years.

The importance of time is illustrated by the retention probability for individuals A and B with the disparite characteristics previously described.[10/] For an A type individual (as for a B type), the probability of retention through boot camp is very high.[11/] Indeed, the differential between the overall probability of retention and the probability of retention for an A type individual is relatively narrow during the first year of service, but it increases rapidly thereafter (see Table 6). Still another way of measuring the impact of time on retention is to compare the probability of remaining in service after one year for a) two-year enlistees without a high school degree and b) four-year enlistees without a high school degree. The one-year retention probability for the first group is .90, for the second group, .88. The probability of reaching EAS, however is .74 for first group but only .38 for the second group.[12/]

[10/] See page 2 for a description of characteristics associated with "A" and "B" individuals. In particular, A is a four-year enlistee with less than a high school education.

[11/] Even though none of the variables is individually important in predicting completion of boot camp, their cumulative effect can be important. As an example, while the probability of completing boot camp is .90 for an A type person, it is only .83 for a white, non-high school graduate, four-year enlistee, in mental group IV or V, who is age 20 or over.

[12/] In examining Tables 2 and 5, one notices that the probability of a two-year enlistee reaching EAS is less than the probability of his completing two years of service. The reason for this is that some individuals must serve more than two years to complete a two-year contract. This is the case, for example, of a person who deserts for three months, since "desertion time" does not count towards fulfillment of the military service contract.

The foregoing discussion indicates that the retention probability of non-high school graduates, particularly those who enlisted for four years, is less than that of high school graduates. The data presented, however, do not provide a basis for assessing qualitative aspects associated with non-completion of one's service obligation. Some information on this point is presented in Table 7 for the 1971 cohort of Marines. The data cover the period 1 January 1971 - 31 December 1972; all individuals counted in the table served a maximum of two years; hence, the time element is held constant. The figures in the table are percentages. The denominator is the number of individuals who separated from the Marine Corps and failed to reach EAS; the numerator is the subset of this group who separated for the one of the six "serious" reasons shown.[13/] As can be seen from this table, the percentage of separations for serious reasons was higher for non-high school enlistees than for high school and was particularly high for four-year, non-high school enlistees.

The same methodology developed for explaining variations in the retention probability could be applied to analyzing the factors influencing the probability of being court martialed, etc. Obviously, this is beyond the scope of the present paper. The data in Table 7 are thus suggestive only, but they do seem to indicate that non-high school graduates are more likely to get into serious trouble than high school graduates, and that the propensity to get into such difficulties is independent of time.

The cohort data provide a basis for assessing another important aspect of retention, i.e., the relationship between retention and military occupation. An important question in this area is whether retention in an occupation depends on the "quality" of the individual assigned to the occupation. This question bears on the extent to which substitution of one quality of labor for another is possible within a

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[13/] Examples of reasons for separation judged to be non-serious are ineptitude, failure to pay debts, and hardships.

TABLE 7

Percent of Individuals Who Did Not Complete Their Service Contract by Level of Education and Reason of Separation: 1971 Cohort [a/]

	High School Graduates		Non-High School Graduates	
	2-year enlistees	4-year enlistees	2-year enlistees	4-year enlistees
Court martial, general and special	0.5	1.2	0.7	1.7
Discharge for the good of the service	1.4	2.3	3.5	5.9
Drugs addiction	3.0	5.2	1.9	5.2
Frequent involvement with authorities	0.5	1.0	0.6	1.9
Character or behavior disorder	8.8	10.2	8.3	10.7
Desertion	4.5	5.7	6.1	9.1
Total	18.7	25.6	21.1	34.5

a/ Covers the period 1 January 1970 through 31 December 1972.

given occupation. Unfortunately, the cohort file as presently structured yields only partial insights into these questions, but these are entirely unexpected. As mentioned earlier, the information on occupation refer, for the most part, to attained skill after training has been completed. Thus, it is not possible to determine the probability of successfully completing training in a specific occupation, since only the occupation in which training was completed is known. However, if the probability of starting and finishing training is low for an individual with a given set of characteristics, it is not unlikely that the probability of reaching EAS, given that the individual completed the training requirements, is also low. That is to say, if an individual is a marginal candidate for training relative to another with better qualifications, it may be expected that the probability of his reaching EAS will also be lower, given that both individuals have completed the same training. The reason for this is that while the marginal candidate may complete training, he may not be as well trained as the individual with better qualifications, and this could contribute to higher attrition after training is completed. Although only inferences can be drawn with respect to the impact of the predictor variables on starting and finishing training, the data permit assessment of the probability of retention given such information as an individual's mental ability, education, and the primary military occupation to which he was ultimately assigned.

Table 8 shows the probability of reaching EAS, given that an individual has completed boot camp. The probability of reaching EAS from boot camp rather than from entrance into the Marine Corps is computed because it is only after the completion of boot camp that an occupational field is assigned. As can be seen from Table 8, the probability of reaching EAS depends on the military occupation; in particular, it is highest for the repair occupations. One reason for this may be that individuals view such training as yielding the largest gains in income in the civilian sector vis-a-vis their income expectations prior to entering the military.

TABLE 8

Probability of Reaching EAS from Boot Camp: [a]
Two-, Three-, and Four-Year Enlistees, 1968 Cohort

		Probability of Reaching EAS
Age:	17 years	.69
	18-19 years	.77
	20 years or over	.77
Race:	White	.78
	Non-white	.70

Length of Enlistment:	Level of Education: Less than H.S.	H.S. or Above
2 years	.79	.90
3 years	.63	.84
4 years	.40	.74
Military Occupation:		
Ground Combat		
Mental Group [b]		
I and II	.62	.81
III	.62	.79
IV and V	.60	.80
General Repair		
Mental Group		
I and II	.69	.88
III	.68	.87
IV and V	.71	.90
Clerical and Semi-Skilled		
Mental Group		
I and II	.66	.87
III	.65	.86
IV and V	.64	.87
Other Skills		
Mental Group		
I and II	.50	.78
III	.51	.77
IV and V	.54	.81

TABLE 8 (Cont'd)

Region: c/

County Population: c/

a/ The overall probability of reaching EAS from boot camp is .75.

b/ Based on the General Classification Test.

c/ Not included.

The unanticipated finding is that the retention probability is virtually independent of mental group when military occupation and educational attainment are taken into account. In other words, although occupational assignment is partially based on the GT score, there is no indication that the retention rate of individuals in Mental Groups I and II is higher than that of, say, individuals in Mental Group III. In particular, although it may be that the former group has a higher probability of successfully completing training in the repair occupations, all other things being the same it appears that the probability of their providing these services through the end of their service contract is no higher than that of the latter group. In contrast, all other things being held constant, educational attainment appears to exert a very strong influence on whether an individual trained in the repair occupations (or any other occupational area) completes his service contract. Holding all other variables constant, the retention rate of high school graduates was approximately thirty percent higher than that of non-high school graduates. By implication, although the data available do not show this, it may be that educational attainment is also a better predictor of ability to start and finish training than intelligence test scores.

It may be suggested that since GT scores and education are correlated, either criterion can be used to maximize the probability of retention in an occupation. This possibility was examined by excluding the education variable from the model (see Table 9). The mental group variable does pick up some of the effect attributable to the education variable, but it is not as efficient a predictor. The retention differentials are reduced by about one-half vis-a-vis when education is included in the model, and they are fairly small between Mental Groups I and II and Mental Group III.

Another explanation for the lack of predictive power of the mental group variable is that Table 8 pertains to all enlistees. Shorter-term enlistees are often assigned to occupations where

TABLE 9

Probability of Reaching EAS from Boot Camp: [a]
Two-, Three-, and Four-Year Enlistees, 1968 Cohort

		Probability of Reaching EAS		
Age:	17 years	.63		
	18-19 years	.79		
	20 years	.80		
Race:	White	.78		
	Non-white	.81		
		Mental Group: [b]		
Length of Enlistment:		I and II	III	IV and V
	2 years	.89	.85	.82
	3 years	.80	.74	.70
	4 years	.66	.58	.55
Military Occupation:				
	Ground Combat	.64	.72	.67
	General Repair	.86	.81	.79
	Clerical and Semi-Skilled	.84	.78	.72
	Other Skills	.71	.63	.60
Region: [c]				
County Population: [c]				

a/ The overall probability of reaching EAS from boot camp is .75.

b/ Based on the General Classification Test.

c/ Not included.

training time is small or minimal and this may influence their attitude toward completing their service contract. That is to say, mental ability may not be an important predictor of retention for two-year enlistees, but it may be important for four-year enlistees. This hypothesis was tested by looking at the retention probabilities of four-year enlistees. However, there is no evidence (see Table 10) of a positive relationship between the probability of retention and GT score for this group.[14/] Indeed, in two of the four occupational groupings the retention probability was higher in Mental Group IV and V than in Mental Group III. Moreover, the differential in the retention probability between high school and non-high school graduates is even more marked than before.

4. Summary

In this paper contingency table analysis is applied to assess the importance of a number of predictor variables on attrition, i.e., the failure to complete one's initial service contract in a satisfactory manner. The data employed come from a unique longitudinal personnel history file which records a variety of significant events during the first enlistment of U. S. Marines. The group of Marines studied is the 1968 cohort; where possible the analysis was extended to enlistees who entered the Marine Corps during 1970. Although the Vietnam War was still in progress, several reasons suggest that the analysis is representative and that similar findings would be obtained if more recent data were available: the Marine Corps had the highest proportion of true volunteers among the four services; the findings for the 1968 cohort of four-year enlistees, which undoubtedly was comprised

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[14/] Models similar to the one underlying Table 10 were also examined for two-year enlistees who entered the Marine Corps in 1968 and in 1970. In only one case, among two-year enlistees in 1970 who were assigned to the "other skill" category, was a positive association found between the probability of retention and GT score.

TABLE 10

Probability of Reaching EAS from Boot Camp: [a]
Four-Year Enlistees, 1968 Cohort

		Probability of Reaching EAS	
Age:	17 years	.52	
	18-19 years	.63	
	20 years	.63	
Race:	White	.66	
	Non-white	.53	
		Level of Education:	
Military Occupation;		Less than H.S.	H.S. or Above
Ground Combat			
Mental Group			
	I and II	.38	.68
	III	.38	.66
	IV and V	.39	.72
General Repair			
Mental Group [b]			
	I and II	.47	.80
	III	.47	.79
	IV and V	.59	.88
Clerical and Semi-Skilled			
Mental Group			
	I and II	.43	.77
	III	.43	.77
	IV and V	.43	.80
Other Skills			
Mental Group			
	I and II	.29	.67
	III	.31	.67
	IV and V	.38	.78
Region: [c]			
County Population: [c]			

a/ The overall probability of reaching EAS from boot camp is .60.

b/ Based on the General Classification Test.

c/ Not included.

almost exclusively of true volunteers, were similar to those for two-year enlistees who enlisted in 1968; the findings for the 1970 cohort of two-year enlistees were similar to those for the 1968 cohort of two-year enlistees. With few exceptions, the findings were highly consistent not only for different groups of individuals but also for different years.

Among the predictor variables examined, two were dominant in influencing the probability of retention, i.e., the probability of reaching end of service (EAS). These were educational attainment and length of enlistment. The remaining variables were found to be unimportant or of low importance. In the former category were regions of residence and population of county of residence at time of enlistment. In the latter group were age, mental group, race, and military occupation; except for military occupation, the relationship between these predictor variables and the probability of retention varied over the enlistment contract period. For example, when all other factors are held constant the retention probability varies inversely with age prior to completion of boot camp but positively with age after the completion of boot camp; in both instances, however, the impact of age on retention is not strong. Likewise, mental group is of low importance in explaning retention through boot camp but is unimportant thereafter.

Two important findings emerge from the study. The first suggests that educational attainment rather than mental ability is the major determinant of retention. This finding was surprising in view of the current Marine Corps practice of assigning individuals to an occupation on the basis of their General Classification Test (GT) score. Although the data do not permit determination of whether individuals with a low GT score are less likely to successfully complete extensive training courses, such as those which characterize the repair occupations, it was anticipated that the factors associated with a low score which could yield this

result would also work to reduce the retention probability given that an individual had qualified and been assigned to an occupation. This expectation, however, was not borne out by the analysis. Instead, it appears that the retention probability after completion of occupational training depends to a great extent on educational attainment and not on GT score. For example, the probability of a four-year enlistee reaching EAS from boot camp, given that he is assigned to a general repair occupation, his mental group is III, and he completed high school, is .79. If his mental group is I or II but he did not complete high school, the retention probability drops to .47. Notwithstanding the fact that the data do not permit an evaluation of the degree to which the GT score is predictive of an individual's ability to successfully complete training, they do indicate that it is a poor predictor of the extent to which the benefits of such training can be realized by the Marine Corps.

From a more general viewpoint, it is noteworthy that the probability of completing one's service contract is very low for the non-high school graduate even when his GT score is high, while it is substantially higher for the non-high school graduate even though his GT score may be markedly lower. Indeed, the probability of a non-high school graduate in Mental Group I or II reaching EAS was one-fifth lower than that of a high school graduate whose test score placed him in Mental Group IV or V. At least in terms of attrition of first-term enlistees, there is little doubt that education is a better predictor of success than intelligence test scores.

A second finding of the study concerns the impact of time on the probability of reaching EAS. In the case of non-high school graduates who enlist for four years, the probability of reaching EAS is .38. This low probability may be due to their being of poorer quality than two-year, non-high school enlistees or because they have more time to get into trouble. The analysis indicates that it is the latter factor which is very important, although the

former is by no means unimportant. To illustrate the importance of time on retention, the probability of a four-year, non-high school enlistee completing two years of service is .68, not much below the .77 probability of a two-year, non-high school enlistee completing two years of service. As indicated by the summary figures below, the retention probability for these two groups is almost the same during the first year of service, and it is not much different from that of high school graduates over the same period of time. However, the passage of time results in a much greater increase in attrition among non-high school graduates than among high school graduates, particularly if the non-high school graduate enlisted for four years.

	Probability of Completing		Probability of Completing Service Contract a/
	one year of service	two years of service	
Non-High School Graduate			
2 year enlistee	.90	.77	.74
4 year enlistee	.88	.68	.38
High School Graduate			
2 year enlistee	.95	.88	.87
4 year enlistee	.94	.87	.71

a/ Based on 1968 cohort data.

These findings suggest several policy related conclusions and alternatives. First, since the proportion of new entrants into the Marine Corps who are four-year, non-high school enlistees has been rising in the all volunteer environment,[15/] the aggregate attrition rate may be expected to increase during the next few years, unless quality standards are reduced. Second, increased emphasis

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15/ In (calendar year) 1974, this proportion reached 28.8 percent.

should be given to enlisting high school graduates, particularly for those occupations where training costs are high and can only be recouped over a relatively long period of time. Since many high school graduates enlist for only two years, however, such a policy would probably have to be coupled with rapid promotion to induce reenlistment for at least two more years (see [4]). Third, increased emphasis should be given to discouraging potential four-year, non-high school enlistees from enlisting because of their high probability of being discharged under detrimental conditions. Fourth, to the extent that non-high school graduates who wish to enlist for four years must be recruited, consideration should be given to restricting the length of enlistment to one or two years only. Assuming that such a policy were pursued, individuals enlisted under these conditions should be assigned to those occupations where training costs are a minimum, presumably the ground combat and some clerical occupations.

It might be suggested that high attrition rates among non-high school graduates pose little problem since the supply of such individuals to the military is generally large even in times of full employment. That the cost of acquisition of non-high school graduates may be low does not mean, however, that the costs of training such individuals are low or that the benefits obtained from such training are high. As the data on cause of separation discussed in the text suggest, the non-monetary costs of reduced morale and discipline, associated with "flunking out" enlistees after their contribution to Marine Corps effectiveness becomes negligible or negative, may be quite high.

As a final comment, the study illustrates the utility of applying contingency table analysis to problems where both individual characteristics and characteristics external to the individual may be important in influencing behavior or choice. This is particularly so when there are important interaction effects. In this study, for

example, the impact of education, or the lack thereof, on attrition depended on length of enlistment. Although it is possible to take account of interaction effects using other multi-dimensional statistical techniques, the flexibility of contingency table analysis makes it most appropriate for problems which are similar in form to the one discussed in this paper.

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